NEW ENGLAND FLOODS OF 1955

PART 2

FLOOD DISCHARGES

Corps of Engineers, U.S. Army - Office of the Division Engineer
New England Division - Boston, Mass.

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APRIL 1956

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PART II - FLOOD DISCHARGES

FOREWARD

This is Part II of a report in five parts c New England Floods of 1955.

The complete report presents the results of preliminary studies and investigations of the floods which occurred in New England as a result of the tropical storms of August and October 1955. The scope of data included in this report is limited to the material useful to the Corps of Engineers in studies pertaining to flood control investigations.

The complete report comprises five parts:

Part I - Storm Data.

Part II - Flood Discharges.

Part III - Flood Profiles.

Part IV - Flood Damages.

Part V - Effect of Flood Control Projects.

NEW ENGLAND FLOODS OF 1955

PART II - FLOOD DISCHARGES

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PART II - FLOOD DISCHARGES

GENERAL INTRODUCTION

1. Scope and Purpose. - Part II describes the floods which occurred in 1955 in southern New England as a result of "Hurricane Diane" and the storm of 14-17 October; analyzes the development of the August flood in the four major river basins; examines the effect of dam and bridge failures on peak discharges; compares the August 1955 flood with previous floods of record and the standard project flood; and describes the effect of recent floods on flood frequencies.

2. Acknowledgement is made to representatives of the United States Geological Survey, state officials, industrial and power companies and to members of many local communities for their cooperation in providing much of the flood data for this preliminary analysis.

3. General Description of Floods. - The floods which occurred on 18-20 August in southern New England as a result of rainfall accompanying "Hurricane Diane" dealt a staggering blow to Massachusetts, Connecticut and Rhode Island. As the torrential rain fell on ground which had been saturated only four days previously by the precipitation from "Hurricane Connie"-this storm had caused some minor flooding and had increased the base flow on many streams-rivers rose rapidly and overflowed their banks. Rapid runoff from the steep terrain of the Berkshires of southwestern New England produced flood flows of

great volume and velocity in western Massachusetts and Connecticut. Many streams in central Massachusetts, eastern Connecticut and Rhode Island experienced peak discharges far surpassing any of previous record as a result of intense concentrations of rainfall.

4. Southern New England was again harassed by floods as a result of the storm of 14-17 October which followed close on the heels of "Hurricane Diane." These floods were, however, generally confined to the southern portion of Connecticut and western Massachusetts, whereas the August floods were distributed over larger areas of Massachusetts, Connecticut and Rhode Island.

"HURRICANE DIANE" FLOODS

5. General. - The floods which followed "Hurricane Diane" occurred on both coastal and inland streams of southern New England and caused widespread flooding in the four major river basins of the region, namely, the Blackstone, Thames, Connecticut and Housatonic. In the Housatonic River Basin there was general flooding throughout the main river, with phenomenally high flood flows, which far exceeded all previous records, occurring on the tributaries, particularly on the Naugatuck, Shepaug and Pomperaug Rivers. Only the lower part of the Connecticut River Basin was affected by the flood. The Westfield and Farmington Rivers had new maximal peak discharges, and on the main river downstream of these tributaries at Hartford, the third highest flood of record occurred. Some of the agricultural

lands of the Connecticut River valley below Springfield were inundated but no flooding occurred north of the Massachusetts-Vermont-New Hampshire border, which marked the limit of high rainfall intensity. (See Part I, Plate No. 3) Floods in the Thames River Basin were concentrated on the two principal tributaries-the Shetucket and Quinebaug Rivers. Flood discharges on the upper Quinebaug River, as well as on its tributaries, exceeded all previous records. New maximal discharges also occurred in the headwaters of the Shetucket River. However, there was no extensive flooding on the Shetucket River below Willimantic, which is downstream of the Mansfield Hollow Flood Control Dam. In the Blackstone River Basin, floods of great magnitude, with peak discharges surpassing those of historical record, occurred on the main river and on all its tributaries.

6. Flood Discharges. - Flood discharges were obtained from the records of the U. S. Geological Survey stream gaging stations which are located on the main rivers and their principal tributaries in southern New England. The locations of these gaging stations, together with supplemental discharge measurements, in the southern New England region affected by the flood are shown on Plate No. II-1. A comparative summary of data collected by the United States Geological Survey for the floods of 1955 and the maximum flood previously known are shown on Table II-1.

7. Incompleteness of Data. - The flood was of such magnitude that it created many abnormal conditions. In some areas gaging

stations were destroyed by the rampaging waters, and in others, the recording instruments were interrupted or stopped when they were inundated by the high stages. At some gaging stations the hydraulic controls were shifted or so affected by deposition of material that it was impossible to obtain satisfactory stage-discharge relationships for the stations during the course of the flood.

8. Timing of Flood Peaks. - Data on timing of flood peaks, which is essential for analyzing the development of floods, have been obtained from various sources. The records of the U.S. Geological Survey provided the principal source, but additional information came from local observers, representatives of industry, and from state, county and community officials. Newspapers also provided information of flood crests in their descriptive accounts of the disaster.

ANALYSIS OF "HURRICANE DIANE" FLOODS

9. General. - All available data regarding the "Hurricane Diane" floods were compiled for purposes of determining the development of the flood and the effect of flood control projects in the four principal river basins affected: namely, the Blackstone, Thames, Connecticut and Housatonic. Examination of the compiled data revealed that difficulties would be encountered in reproducing flood hydrographs at many locations where stream gage records were interrupted or destroyed by flood waters. In the analysis of the flood in each basin many of

the hydraulic and hydrologic methods and procedures established in the NENYIAC study were used, particularly in the development of synthetic hydrographs for ungaged areas and in the determination of tributary contributions to downstream flood peaks. In the analysis of the floods, synthetic hydrographs for ungaged areas were developed from hydrographs of gaged areas with similar characteristics as to rainfall-runoff and area-discharge relations. The Lag-Average routing method was used to perform flood routings.

10. Blackstone River Basin. - The flood resulting from the "Hurricane Diane" storm on the Blackstone River and its principal tributaries was approximately twice the magnitude of any flood of record. Several days prior to the occurrence of the flood, "Hurricane Connie" deposited nearly five inches of rainfall on the basin which saturated the ground and filled the many lakes and mill ponds. However, the runoff associated with this storm failed to cause any significant rise in the rivers.

11. During the afternoon of 17 August rainfall accompanying "Hurricane Diane" began and increased in intensity to such a degree that accumulations in excess of five inches were recorded by nightfall of the 18th. Heavy rainfall continued throughout the evening of the 19th until the storm finally moved out to sea, leaving an average of twelve inches over the basin with total accumulations ranging from eight to fifteen inches.

12. On the 18th and 19th of August, the streams in the basin began to rise, Kettle, Tatnuck and Mill Brooks in the headwaters cresting around noon on the 19th. The Quinsigamond River, a naturally sluggish stream, rose slowly and crested around 6:00 a.m. on the 20th. Further downstream, flood crests occurred at midnight on the 19th at Northbridge on the Blackstone, and at the mouths of the Mumford, West, and Branch Rivers. At Woonsocket, the failure of Harris Pond Dam on the Mill River caused the occurrence of an unnatural peak discharge on the Blackstone River some 14 hours earlier than the arrival of the flood wave traveling down the main river.

13. The timing of the flood peaks on the Blackstone River is a function of its hydraulic characteristics. The river is quite flat throughout its entire length with extensive valley storage which exerts a great modifying effect on flood flows. While the principal tributaries are not flashy, their peak contributions, which occur on the rising side of main river hydrograph, advance the timing of peak on the Blackstone River.

14. The location of the five U.S. Geological Survey stream-gaging stations and points of supplemental discharge measurements in the Blackstone River Basin are shown on Plate No. II-1. During the flood several gages were interrupted, including the Northbridge gage, when a debris-clogged highway bridge upstream failed and released a surge of impounded water, and the Woonsocket gage, when Harris Pond Dam on Mill River gave way and caused a similar surge.

15. The development of the flood in the Blackstone River Basin was analyzed by dividing the basin into tributary watersheds, which could be represented by observed or synthetic hydrographs, and by separating the main river into routing reaches. Gaged hydrographs for Kettle Brook, Quinsigamond River, Branch River and the Blackstone River at Northbridge and Woonsocket were obtained from the U.S. Geological Survey. Synthetic hydrographs for the Mumford, West, Mill and Peters Rivers and smaller ungaged streams were developed by a comparison of the distribution of rainfall, runoff characteristics and timing of peak discharges of these watersheds with similar watersheds for which observed hydrographs were available. The routing reaches on the main river were selected at hydraulic control points in order to reproduce the observed hydrographs at Worcester, Northbridge and Woonsocket.

16. The individual tributary hydrographs were combined in their proper sequence and then routed downstream in accordance with previously developed routing coefficients. A graphical representation of the routed component hydrographs which comprise the flood hydrograph at Woonsocket is shown on Plate No. II-2. The discharge contributions of the various tributaries to the flood peak at Worcester, Northbridge and Woonsocket are summarized in Table II-2. The peak discharge profile and tributary contributions to the flood peak along the Blackstone River are shown graphically on Plate No. II-3.

17. The Blackstone River Basin, which is small in comparison with other river basins in southern New England, received high amounts of rainfall, (See Part I, Plate No. 3) resulting in a high volume of runoff. The Kettle Brook gaging station at Worcester had 7.0 inches of runoff, the Northbridge gaging station 5.5 inches, and the Woonsocket gaging station 5.0 inches.

18. The principal flood producing tributaries during the August flood were Kettle Brook, Tatnuck and Mill Brooks, Mumford River, West River, and Mill and Peters Rivers. These tributaries, representing 48 per cent of the drainage area above Woonsocket, contributed 59 per cent of the peak discharge at the Woonsocket gage. The Quinsigamond and Branch Rivers have a considerable amount of natural storage, and although representing 30 per cent of the total drainage area above Woonsocket, they contributed only 15 per cent of the peak discharge at Woonsocket. The time of travel of the peak discharge on the main river was approximately 24-hours between Worcester and Woonsocket, a distance of 31 miles.

19. Thames River Basin. - The flood of August 1955 was the flood of record in the watersheds of the upper Shetucket River and the entire Quinebaug River. As shown in Table II-1 the peak discharges on the Quinebaug River were two to three times the magnitude of the previously recorded floods. The reason for such a large flood may be explained in part by an inspection of the isohyetal map. (Part I, Plate No. 4) The rainfall over the area above Putnam,

Connecticut ranged from eight to 17 inches with an average rainfall of about 12.5 inches for the entire drainage area of 311 square miles.

20. The failure of many dams and bridges that acted as temporary dams also contributed to the high discharges. These failures created surges that may have synchronized with the natural flood peaks, or perhaps set up a "chain reaction" where a series of failures may have been instrumental in maintaining the abnormally high discharges. An extreme example of this condition was the failure of Glenecho Dam on Cady Brook in Charlton City, Massachusetts. Failure of the dam during the morning of 19 August produced a tremendous surge that destroyed several other smaller dams in Charlton City and continued unabated down Cady Brook to the Quinebaug River at Southbridge, Massachusetts. The drainage area of Glenecho Reservoir is 2.1 square miles. In Southbridge, where the drainage area of Cady Brook is 12 square miles, the U.S. Geological Survey determined from slope-area measurements that the peak discharge of this surge was 26,300 c.f.s.

21. Based on the meager data available, the peak discharge on the Quinebaug River below Cady Brook at Southbridge is estimated to have been between 35,000 and 40,000 c.f.s. Failure of Glenecho Dam on Cady Brook and of the Globe Dam in upper Southbridge introduces a very complex hydrologic problem. So far, no satisfactory analysis has been made to show the component flows in the development of the flood in the Quinebaug River from Southbridge to Quinebaug below the

Massachusetts-Connecticut state line.

22. The maximum stage of 26.5 feet at Putnam, Connecticut occurred at approximately 9:00 p.m. E.D.S.T. on the 19th with a discharge of 48,000 c.f.s. This was more than twice the previous maximum of 20,900 c.f.s. recorded in September 1938, although the average rainfall in September 1938 was 11.7 inches or 93 per cent of the total in August 1955. The differences in the peak discharges with almost the same amount of rainfall can be explained by comparing the rainfall distribution and the antecedent conditions. In September 1938 the rainfall was distributed over a five day period (17-21) with approximately 50 per cent of the total occurring on 21 September. In August 1955 the entire storm was of approximately 36 hours duration with more than 50 per cent of the rain occurring within the six hour period from 2:00 a.m. to 8:00 a.m. or 19 August. This rainfall, coupled with the saturated ground conditions due to "Hurricane Connie" rainfall, resulted in an estimated flood runoff volume of 9.6 inches compared to 5.4 inches for the September 1938 flood. The hydrograph analyses at Putnam involved the use of data for the gaging station located on the French River at Webster and the estimated hydrograph for the Quinebaug River at Quinebaug. Synthetic hydrographs were developed for the ungaged areas. The estimated component hydrographs contributing to the flood at Putnam, Connecticut are shown on Plate No. II-2.

23. The Quinebaug River between Putnam and Jewett City, Connecticut contains extensive storage and is relatively flat. The average

slope is six feet per mile compared to an average of 13 feet per mile above Putnam, and an average of 24 feet per mile in the French River. Because of the storage and flat slopes, plus smaller amounts of rainfall (average of six inches over 380 square miles of watershed below Putnam), this area contributed only 13 per cent of the total recorded flow of 40,700 c.f.s. at Jewett City, Connecticut. The area above Putnam, Connecticut, representing 47 per cent of the drainage area, contributed 87 per cent of the peak discharge at Jewett City. This compares with 60 per cent during the previous maximum flood of 29,200 c.f.s. in March 1936 and 76 per cent of the peak discharge of 22,800 c.f.s. in September 1938. Contributions to the peak discharge at various locations on the Quinebaug River for the flood of August 1955 are shown on Plate No. II-3, and summarized in Table II-3.

24. The Willimantic River is the only major tributary of the upper Shetucket River that experienced a record breaking flood during August 1955. This was due to the heavy rainfall combined with dam and bridge failures. The peak discharge computed by the U.S. Geological Survey for the South Coventry gage is 24,200 c.f.s., while in September 1938 the maximum discharge was 15,500 c.f.s. In September 1938 the volume of runoff was 8.7 inches from an average rainfall of 14 inches as compared to a runoff volume of 7.5 inches from an average rainfall of 11 inches experienced in August 1955.

25. The total discharge on the Shetucket River near Willimantic was 21,300 c.f.s. with most of the flow coming from the

Willimantic River, since the flow on the Natchaug River was controlled by the flood control dam at Mansfield Hollow. It is estimated that the flood control dam reduced the discharge by approximately 16,000 c.f.s. which would have made the natural uncontrolled flow 37,300 c.f.s. at the gaging station. This would still be less than the maximum discharge of 52,000 c.f.s. recorded during the flood of September 1938.

26. The experienced flow at Norwich, Connecticut was estimated to be 56,000 c.f.s. Without the regulation at Mansfield Hollow Reservoir, it is estimated the flow would have been 65,500 c.f.s. This compares with the 75,000 c.f.s. experienced in September 1938 and 51,500 c.f.s. in March 1936. The contributions to the peak discharges of the August 1955 flood for various locations on the Shetucket River are shown on Plate No. II-3.

27. Connecticut River Basin. - Heavy rainfall accompanying "Hurricane Connie" soaked the lower Connecticut River Basin and set the stage for the rapid runoff which followed the intense rainfall associated with "Hurricane Diane." Since antecedent conditions were very dry, "Connie's" rainfall, which ranged from four to nine inches over the southern part of the Connecticut River Basin resulted in only minor rises on the tributaries.

28. During "Hurricane Diane," tributaries in the lower Connecticut River Basin experienced two separate rises. The first

rise, which was caused by "Diane's," initial rainfall, occurred on 18 August. The rainfall during the morning and afternoon of the 18th ranged from three to six inches and resulted in minor flooding. The flow of the Westfield River at Westfield, Massachusetts increased from 770 c.f.s. at 7:00 a.m. on 18 August to a peak discharge of 19,300 c.f.s. at 8:00 p.m. on 18 August. The river receded to a flow of 16,400 c.f.s. at 1:00 a.m. on 19 August. On the evening of 18 August intense rainfall spread into the lower Connecticut River between Montague City, Massachusetts and Middletown, Connecticut, and continued until the early morning of the 19th. During this period, 12 inches of rain was recorded at Westfield, Massachusetts and lesser amounts over the remaining area. The flow on the Westfield River at Westfield rose rapidly from 16,400 c.f.s. at 1:00 a.m. to a peak discharge of 70,300 c.f.s. at 7:00 a.m. Similar rapid rises were noted on the Middle and West Branches of the Westfield River.

29. The southern portion of the Chicopee River watershed, including the Quaboag River, suffered from flood flows 1.5 times the previous maxima. The northern portion of the watershed received much less rainfall and flood flows were approximately one half the maximum of record. The combined flows from the Quaboag and Ware Rivers produced a peak discharge of 40,500 c.f.s. at Indian Orchard compared with a maximum recorded in September 1938 of 45,200 c.f.s.

30. The entire Farmington River watershed experienced discharges greater than any previously recorded. The streams rose rapidly on the evening of the 18th and crested on the morning of the 19th. Although the flood flows of the Farmingtion River were modified by the vast amounts of valley storage in the lower portion of the watershed, the Farmington River was the largest contributor to the peak of the Connecticut River flow at Middletown. (See Table II-3)

31. The raging flood waters on the tributaries in southern Massachusetts surged into the Connecticut River so quickly that the peak discharge at Thompsonville, Connecticut occurred only 24-hours after the beginning of intense rainfall. The peak flow of 174,000 c.f.s. at Thompsonville, generated entirely by the area below Montague City, was exceeded only by the November 1927, March 1936, and September 1938 floods. The smaller tributary streams in Connecticut were heavy contributors to the flood peaks on the lower Connecticut River. The Scantic and Park Rivers considerably exceeded past floods of record. At Middletown, Connecticut the maximum discharge of 177,000 c.f.s. was exceeded only by the March 1936 and September 1938 floods.

32. The development of the flood on the lower portion of the Connecticut River Basin below Montague City was analyzed in detail to determine contributions form the various watersheds. The observed hydrographs were combined in their proper sequence and routed downstream using Lag-Average routing coefficients developed from previous

studies. Synthetic hydrographs for the ungaged local areas were determined by comparison of these ungaged areas with gaged areas for which observed hydrographs were available. The individual hydrographs were routed downstream to determine their contributions to the flood peak at downstream locations. A graphical representation of the routed component hydrographs which add up to the recorded flood hydrograph at Middletown, Connecticut is shown on Plate No. II-2. The peak discharge profile contributions of the various tributaries to flood peaks along the Connecticut River are summarized in Table II-4 and are shown graphically on Plate No. II-3.

33. The three major flood producing tributaries during the August flood were the Chicopee River, with a unit discharge of 59 c.f.s./sq. mi.; the Westfield River, with 141 c.f.s./sq. mi.; and the Farmington River, with 118 c.f.s./sq. mi. These three tributaries, representing but 16 per cent of the drainage area above the Middletown gage, contributed 49 per cent of the peak discharge at that location. In contrast, the Connecticut River watershed above Montague City, representing 72 per cent of the total drainage area, contributed only 15 per cent of the peak discharge at Middletown.

34. Housatonic River Basin. - The August 1955 flood was of major proportions in most areas of the Housatonic River Basin. In the upper portion of the basin, which experienced the lesser amounts of rainfall, the headwater tributaries produced relatively high rates of runoff. In the north central portion of the basin the flow on

the Housatonic River at Falls Village nearly equalled the previous maximum, which occurred in 1949. Further downstream at Gaylordsville, the flood was 1.6 times the peak of the September 1938 flood, the previous maximum. At Stevenson, in the lower portion of the basin, the August flood was just slightly less than the previous maximum discharge of the 1938 flood as a result of the modifying effect of the partially completed Shepaug development of the Connecticut Light and Power Company.

35. The principal tributaries of the Housatonic River were subjected to flood flows far exceeding the previous maximal discharges. The August flood on the Tenmile River was 1.6 times the peak discharge of the September 1938 flood, while the Shepaug and Pomperaug Rivers experienced flows between four and five times the previous maxima of 1938.

36. The Naugatuck River, which is the largest tributary of the Housatonic River, suffered catastrophic effects of the flood. The unprecedented magnitude of the flood, which wrought such great destruction to the communities throughout this highly industrialized valley, led to a detailed hydraulic analysis of the development of the flood on the Naugatuck River.

37. The Naugatuck River watershed received a soaking from the rainfall accompanying "Hurricane Connie" which primed the watershed and rivers for the rainfall that came with "Hurricane Diane." Between 11-14 August, "Connie" produced between eight and nine inches

of rain in the upper part of the Naugatuck River watershed, and four and five inches near the mouth of the river. Because of dry antecedent conditions the runoff was not commensurate with the rainfall and only an insignificant rise was noted on the rivers.

38. Between three and four inches of rain fell over the upper part of the Naugatuck River Basin during the morning and early afternoon of 18 August. This produced immediate runoff and a rapid rise in river flows. The discharge at the Thomaston gage rose from 100 c.f.s. at 6:00 a.m. to a peak of about 4,700 c.f.s. at 4:00 p.m. The flow receded to 2,000 c.f.s. by 10:00 p.m. Similar rapid rises were noted on the nearby Leadmine Brook where the discharge increased from 40 c.f.s. at 6:00 a.m. to 2,100 c.f.s. at 10:00 a.m. and then receded to 700 c.f.s. by 9:00 p.m. It is important to note that these flows were progressing down the Naugatuck River during the night of 18 August.

39. Heavy rainfall developed again during the late evening of the 18th and continued into the early morning of the 19th. Eight to nine inches of rain fell within this period, most of it occurring within the six-hour period from 9:00 p.m. to 3:00 a.m. The rivers now rose with phenomenal rapidity and the maximum discharges in the upper reaches of the Naugatuck River crested even before the cessation of rain. At Thomaston the river rose 19 feet in seven hours-it rose four feet between 2:30 to 3:00 a.m.-and crested at 5:30 a.m. on 19 August with a discharge of 41,600 c.f.s.

Leadmine Brook peaked concurrently with a discharge of 10,400 c.f.s. Downstream, the Naugatuck River, already flowing nearly full from the rainfall occurring early on 18 August, now rose rapidly. At Naugatuck, the river stage rose 19 feet in ten hours peaking at 10:30 a.m. with a discharge of 106,000 c.f.s.

40. It is estimated that the flood crest occurred on 19 August at different localities at the following hours:

Location	Time of Peak Discharge (E.S.T.)
Torrington	5:00 to 6:00 a.m.
Thomaston	5:30 a.m.
Waterbury	9:00 a.m.
Naugatuck	10:30 a.m.
Ansonia	1:00 p.m.

The above table indicates that the flood crest traveled from Thomaston to Ansonia, a distance of 28 miles, in approximately 7.5 hours, representing an average velocity of about four miles per hour, or six feet per second. It should be noted that this velocity refers to the translation of the flood crest. Actual velocity of flow in the river channel was much higher, probably reaching 12 to 15 feet per second in many sections.

41. Because the initial rain saturated the ground and produced a minor flood runoff on 18 August, the heavy rainfall occurring during the night of 18 August and morning of 19 August produced very rapid

runoff which apparently concentrated almost simultaneously throughout the river valley. This rapid concentration explains in part the tremendous peak discharges experienced on the Naugatuck River, which were [illegible] four times the previous floods of records. The flood crest in the upper part of the watershed in the vicinity of Torrington was aggravated by the failure of several small upstream dams. However, the magnitude of the flood was so great that the effect of the dam failures was quickly lost and it is considered that their influence on the high downstream flood peaks was negligible.

42. The high discharges greatly exceeded those normally to be expected from the experienced rates of rainfall. At Thomaston, for example, the peak flow was equivalent to a rate of rainfall of nearly one inch per hour, an inconceivably high rate for 72 square miles, particularly in view of the fact that average rainfall rates over the watershed probably did not exceed two inches per hour. Downstream at Naugatuck the maximum discharge was equivalent to an incredible 0.7 inches of rainfall per hour for a drainage area of 246 square miles.

43. It is believed that the high flood peaks must be explained in part by the channel hydraulics on the Naugatuck River. The slope of the river is steep and has a continuous drop averaging 14 feet per mile from Torrington to the mouth of the river at Derby. There is very little storage within this valley to modify flood peaks. During the flood all the small tributaries of the Naugatuck River

poured in their torrents of water almost simultaneously. This great influx of water exceeded the natural channel capacity of the Naugatuck River and resulted in considerable depth of water and over-bank flooding to accommodate the flow. It is theorized that this depth and over-bank flooding changed the usual hydraulic characteristics produced during normal flow in the basin. Instead of being influenced by localized hydraulic gradients the flood waters were affected by the overall slope of the Naugatuck River. The combined effect of this slope, plus the greater hydraulic radius due to the utilization of the entire river valley, produced high velocities. Many observers in describing the flood have noted its remarkably quick development that appeared comparable to a tidal wave.

44. It is also thought that the debris dams, forming at many bridges and temporarily checking the flow, aided in the quick build-up in depth and volume of water. In many cases the tremendous presser of this build-up finally broke up the debris dam and destroyed the bridge, releasing a surge to progress downstream. Because of the lack of natural valley storage and the slope of the river, these surges often continued unabated. It is very likely that these surges caused failures of other downstream debris dams, and eventually developed into a chain reaction of failures that tended to pyramid the magnitude of each new surge.

45. The record at the U.S. Geological Survey gage in Thomaston shows that the volume of runoff in the three day period from 18 to 20

August inclusive was 19,200 day-second-feet, equivalent to a runoff of 10.2 inches from the watershed of 72 square miles. The average rainfall producing this runoff is estimated to be approximately 13 inches. Similar analysis of the record at the gage on Leadmine Brook for the same three day period indicated a runoff of 5,020 day-second-feet, or 7.8 inches from the watershed of 24 square miles. Both station records are indicative of a very high volume of runoff that occurred through this flood and demonstrate the effect of antecedent conditions on the development of flood peaks.

46. For hydraulic analysis the Naugatuck River was divided into areal subdivisions and routing reaches. The areal subdivisions included gaged areas and ungaged local areas. The limits of the routing reaches were taken at hydraulic control points, namely the U.S. Geological Survey gage at Thomaston, the U.S. Geological Survey gage at Naugatuck, and the Kinneytown dam at Ansonia. Hydrographs developed by the U.S. Geological Survey for the Naugatuck River at Thomaston, Leadmine Brook at Thomaston, and Naugatuck River at Naugatuck were utilized, insofar as possible. Synthetic hydrographs were developed for the ungaged areas between Thomaston and Naugatuck, and Naugatuck and Ansonia, based on studies of rainfall distribution and runoff hydrographs from comparable gaged areas. The component hydrographs from the tributaries and ungaged areas were routed downstream to determine their contributions to the main river peaks. Allowance was made for the distance of travel, the storage in the reach, the amount of intervening inflow, and the

relative timing of the peak flows.

47. The Progressive Lag-Average Method of flood routing, adopted in previous studies, was used to route the component hydrographs of the Naugatuck River. However, routing coefficients determined in previous studies for floods of lesser magnitudes were found to be inapplicable for the August 1955 flood. New routing coefficients, which reflect the unusual hydraulic conditions of the river during the August flood, were derived. Plate No. II-3 shows the result of the hydraulic analysis of the flood on the Naugatuck River. Discharge contributions to the flood peak at selected locations are summarized in Table II-5. Plate II-2 shows the estimated components and the flood hydrograph at Naugatuck compared with the flood hydrograph determination of the U.S. Geological Survey.

OCTOBER 1955 FLOODS

48. General. - The floods which occurred as a result of the storm of 14-17 October were confined to southwestern Connecticut and western Massachusetts with major flooding in the lower Housatonic River Basin and in the coastal region of Connecticut. The storm was accompanied by abnormally high tides which contributed to the flooding of coastal streams in southern New England. New maximal discharges were recorded near Lanesville on the Still River, a tributary of the Housatonic River, at Stevenson on the Housatonic River and on the Saugatuck River, a coastal stream

near Westport, Connecticut. Undoubtedly, record high flood discharges occurred on many other streams, but no data on them is presently available. The Norwalk River and other small coastal streams in this part of Connecticut also experienced catastrophic floods that exceeded all historical floods within memory of the residents.

49. A summary of the October flood discharges is included in Table II-1. A detailed analysis of the October flood was not undertaken at this time because of the limited amount of flow data with reference to the coastal streams and because of the small areal distribution of flooding.

EFFECT OF BRIDGE AND DAM FAILURES

50. General. - The failure of bridges and dams was widespread in southern New England during the "Hurricane Diane" Floods, occurring on small streams and brooks, as well as on the major rivers. Prior to the failure of many bridges, as in Putnam, Torrington and Waterbury, floating debris collected at the piers, choked the openings and formed artificial dams. As the dammed waters rose, properties adjoining and upstream of the bridges were flooded. When the rupture finally occurred, the water was released in a surge which caused an abnormal peak flow immediately downstream. In many instances this surge diminished as it traveled downstream as a result of the natural valley storage, but in some steep rivers, which lacked adequate valley storage, the surges probably continued unchecked for

considerable distances. On the Naugatuck River it is believed that the surge from one bridge failure may have caused the subsequent failure of other bridges downstream. Such "chain reactions" may have caused pyramiding of the surges and produced the phenomenal discharges that occurred in this watershed. Except where these failures occurred within close proximity of a gaging station, it is difficult to determine their hydraulic effect on flood hydrographs. In most instances accurate data concerning the time of failure, the volume of water released and the type of failure, i.e., complete rupture, partial breach, or wash-out around abutments, were not ascertainable.

51. Failure of Harris Pond Dam. - The Harris Pond Dam, also known as Horseshoe Dam, located in Woonsocket, Rhode Island, on Mill River, a short distance upstream of the confluence of Mill River with the Blackstone River, was breached at approximately 10:00 p.m. E.D.S T. on 11 August. The released waters surged through the Social District of Woonsocket and into the Blackstone River. The U.S.G.S. gage at Woonsocket is located on the Blackstone River just downstream of the Mill River. Unfortunately, the gage failed a few hours before the Harris Pond Dam was breached but from local observations and knowledge of upstream discharges, the U.S.G.S. reconstructed the hydrograph shown on Plate No. II-4. From flood marks on the Blackstone River it was estimated that as a result of the dam failure there was an abnormal peak discharge of 32,900 cubic

feet per second occurring about 14 hours earlier than the natural peak flow of 29,600 cubic feet per second.

52. In general, except for the spectacular dam failures, such as those of Harris Pond Dam and Glenecho Dam on Cady Brook near Charlton City, Massachusetts, the majority of the dam failures produced only minor downstream effects. The volume of natural runoff during the flood was so tremendous that the additional releases from the numerous small ponds or lakes, or from run-of-river projects, were quickly lost in the general flooding. Except for the Harris Pond Dam failure, insufficient information is available for satisfactory evaluations of the effects of dam failures.

EFFECT OF RECENT FLOODS ON FLOOD FREQUENCIES

53. General. - The Beard method of computing peak discharge-frequencies is based on the normal distribution of the logarithms of the annual maximum discharges. This procedure, described in a paper entitled, "Statistical Methods in Hydrology" by Leo R. Beard, and distributed with Civil Works Engineer Bulletin No. 52-24, was adopted by this office and used in the recent NENYIAC studies. The detailed methods of analysis, as applied to New England, are described in F.C.S. Memorandum No. 52-General-3, subject: "Flood Frequency Studies in New England," dated 6 August 1952.

54. Revision of Previous Frequency Statistics. - The peak discharges of the August 1955 flood were applied to the previously

computed frequency curves at numerous locations. This comparison indicated occurrence intervals which, in some cases, were far in excess of 10,000 years for stations with records of 20 years or longer. These findings necessitated recomputation of the frequency statistics based on station records through 1955, for areas affected by the August flood. The revised statistics, which reflect the flows experienced during the last five years, were higher than the previously computed statistics, particularly with respect to the standard deviations. The effect of these revisions was to move the upper portion of the frequency curve to the right, making the occurrence of a flood of a given magnitude more frequent. The extent of the change resulting from the revised frequency statistics with the previously adopted 0.30 skew is illustrated by curves 1 and 2 on Plate No. II-5.

55. The floods of recent years, particularly those in 1954 and 1955 affecting southern New England, give a strong indication of a higher skew. A new skew, based on the composite records of more than 25 stations with 23 to 45 years of record, was computed and correlated with the long record at Hartford. This computation resulted in a positive skew of 1.0.

56. The effect of this higher coefficient of positive skew is to move the upper portion of the frequency curve to the right, making the occurrence of a flood of a given magnitude more frequent. The extent of the change resulting from this greater skew is

illustrated by curves 2 and 3 on Plate No. II-5. As a result of this frequency analysis, the computed skew coefficient of 1.0 was tentatively adopted for the tributary streams of southern New England. Further consideration will be given to revising the skew in other regions of New England.

COMPARISON WITH OTHER FLOODS

57. General. - Several floods of major proportions have been experienced in the river basins of southern New England since the region was first settled by man. Some of the more recent floods with discharge records are those of November 1927, March 1936, September 1938, December 1948, and September 1954. The August 1955 flood was of such outstanding magnitude that it far surpassed these previous floods. A comparison of the peak discharge of the August flood and floods of record at selected locations in the four principal river basins of southern New England is shown graphically on Plate No. II-6.

58. Comparison with Standard Project Flood. - The August 1955 flood approached the magnitude of the Standard Project Flood-a computed flood used to determine the degree of protection afforded by flood control measures. (See Plate No. II-6) A comparison of the storms producing these floods indicates higher total rainfall accumulations associated with the "Diane" storm, but greater rainfall intensities occurring in the Standard Project Storm. (The Standard Project Storm is outlined in Civil Works Engineer Bulletin

No. 52-8.) The high rate of runoff associated with the recent storms illustrates the importance of wet antecedent ground conditions in producing floods of great magnitude. In view of the magnitude and hydrologic characteristics of the August flood, reviews of Standard Project Flood determinations in New England are essential.

TABLE II-1

SUMMARY OF FLOOD DISCHARGES IN SOUTHERN NEW ENGLAND

(Compiled by U.S. Geological Survey)

No.	STREAM AND LOCATION	DRAINAGE AREA (Sq. Mi.)	PREVIOUS MAXIMUM FLOOD				AUGUST 1955 FLOOD				OCTOBER 1955 FLOOD			
			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	MERRIMACK RIVER BASIN													
1*	Assabet River at Maynard, Mass.	116	Sept. 13, 1954	6.47	1,870	16.1	20	8.96	4,270	36.8	17	5.39	1,280	11.0
2*	Concord River below River Meadow Brook, at Lowell, Mass.	405	July 29, 1938	8.11	3,790	f 12.1	23	8.97	4,540	f 14.6	19 or 20	7.27	2,340	5.8
	CHARLES RIVER BASIN													
3*	Charles River at Charles River Village, Mass.	184	July 27, 1938 March 1936	9.00 --	3,110 3,170	16.9 17.2	23	9.24	3,220	17.5	20	4.77	1,150	6.2
4*	Mother Brook at Dedham, Mass.	--	July 28,29,1938	91.84	909	--	24	92.90	960	--	22	89.49	372	--
5*	Charles River at Waltham, Mass.	251	Mar. 19, 1936	4.79	2,540	10.1	19	5.35	2,490	9.9	18	3.66	1,100	4.4
	NEPONSET RIVER BASIN													
6*	Neponset River at Norwood, Mass.	35.2	May 9, 1954 July 24, 1938	10.90 g 11.05	430	12.2	19	g 14.65	1,450	41.2	17	10.62	373	10.6
	TAUNTON RIVER BASIN													
7*	Taunton River at State Farm, Mass.	260	Dec. 8, 1945 May 18, 1954	11.57 11.57	3,190 3,190	12.3 12.3	22	13.02	4,280	16.5	18	7.70	1,930	7.4
8*	Wading River at West Mansfield, Mass.	19.2	May 9,10, 1954	4.89	188	9.79	20	6.22	517	26.9	18--19	4.89	174	9.1
9*	Wading River near Norton, Mass.	42.4	Mar.12,13,1936	10.01	1,030	24.3	20	10.98	1,170	27.6	17	8.57	457	10.8
	PROVIDENCE RIVER BASIN													
10*	Kettle Brook at Worcester, Mass.	31.3	Mar. 18, 1936	g 8.58	2,520	80.5	19	g 12.78	d 3,970	127.	16	5.65	825	26.4
11*	Quinsigamond River at North Grafton, Mass.	25.5	Sept. 12, 1954	3.50	395	15.5	20	5.15	840	32.9				
12*	Blackstone River at Northbridge, Mass.	139	Mar. 19, 1936 Sept. 12, 1954	13.70 11.36	7,510 4,510	54.0 32.4	19	--	16,900	122	16	9.48	2,830	20.3
13	Mumford River at East Douglas, Mass.	27.8	Mar. 22, 1948	5.10	420	15.1	19	g 12.0	d 2,140	77.0	--	--	--	--
14	Blackstone River at Blackstone, Mass.	259	March 1936	--	11,800	45.6	19	--	d 18,800	72.6	--	--	--	--
15*	Branch River at Forestdale, R. I.	93.3	Sept. 12, 1954 March 1936	9.12 --	2,900 5,800	31.1 62.2	19	10.52	4,240	45.4	16	8.33	2,550	27.4
16*	Blackstone River at Woonsocket, R. I.	416	July 24, 1938	14.43	15,100	36.3	19	21.8	ai 32,900	--	17	10.12	8,710	21.0
	THAMES RIVER BASIN													
17	Crystal Lake Brook near West Stafford, Conn.	5.63	--	--	--	--	19	--	a 784	134	--	--	--	--
18	Willimantic River near Stafford Springs, Conn.	53.5	--	--	--	--	19	--	a 14,500	271	--	--	--	--
19	Roaring Brook near West Wilmington, Conn.	18.0	--	--	--	--	19	--	o 2,920	162	--	--	--	--
20*	Willimantic River near South Coventry, Conn.	121	Sept. 21, 1938	18.08	15,500	128	19	g 18.66	b 24,200	200	16	9.29	2,990	24.7
21*	Hop River near Columbia, Conn.	76.2	Sept. 21, 1938	g 16.25	6,450	84.6	19	g 15.10	4,620	60.6	16	g 14.20	4,820	63.3
22*	Safford Brook near Woodstock Valley, Conn.	4.08	Sept.11, 1954	5.89	566	139	19	6.68	oe 1,000	245	16	4.55	242	59.2
23*	Mount Hope River near Warrenville, Conn.	29.1	Sept. 11, 1954	9.20	1,500	51.5	19	10.41	b 5,590	192	16	6.63	912	31.4
24*	Natchaug River at Willimantic, Conn.	169	Sept. 21, 1938	g 16.39	32,000	189	19	5.68	h 1,470	--	19	8.57	h 3,230	--
25*	Shetucket River near Willimantic, Conn.	401	Sept. 21, 1938	g 27.6	52,200	130	19	17.36	h 21,300	--	16	11.61	h 9,580	--
26*	Little River near Hanover, Conn.	29.8	Sept. 12, 1954	5.32	935	31.4	19	6.48	1,400	47.0	16	6.04	1,220	41.0
27	Wales Brook near Wales, Mass.	3.71	--	--	--	--	19	--	a 1,080	291.	--	--	--	--
28	Hamilton Reservoir Outlet near Holland, Mass.	24.2	--	--	--	--	19	--	b 6,540	270	--	--	--	--
29	Quinebaug River at Fiskdale, Mass.	67.5	Sept. 1938	--	7,000	103	19	--	a 15,400	228	--	--	--	--
30*	Quinebaug River at Westville, Mass.	93.8	Mar. 22, 1948 Sept. 1938	6.93 --	1,500 8,400	16.0 89.6	19	16.11	a 17,500	187	17	6.81	1,510	16.1

TABLE II-1

SUMMARY OF FLOOD DISCHARGES IN SOUTHERN NEW ENGLAND

(Compiled by U.S. Geological Survey)

No.	STREAM AND LOCATION	DRAINAGE AREA (Sq. Mi.)	PREVIOUS MAXIMUM FLOOD				AUGUST 1955 FLOOD				OCTOBER 1955 FLOOD			
			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	THAMES RIVER BASIN-Continued													
31	Upper Sibley Pond Outlet at Charlton City, Mass.	2.23	--	--	--	--	19	--	de 1,240	556	--	--	--	--
32	Cady Brook at Southbridge, Mass.	12.0	--	--	--	--	19	--	ai 26,300	--	--	--	--	--
33	Cohasse Brook at Southbridge, Mass.	2.87	--	--	--	--	19	--	d 1,280	446	--	--	--	--
34	Lebanon Brook at Southbridge, Mass.	10.0	--	--	--	--	19	--	d 1,140	114	--	--	--	--
35	Alder Meadow Brook near Spencer, Mass.	2.18	--	--	--	--	19	--	a 1,530	702	--	--	--	--
36	French River at North Oxford, Mass.	24.1	Mar. 18, 1936	--	2,030	84.2	19	--	ad 8,540	354	--	--	--	--
37	South Fork Little River at outlet of Granite Reservoir at S. Charlton, Mass.	7.97	--	--	--	--	19	--	de 2,060	258	--	--	--	--
38e	Little River at Buffumville, Mass.	27.7	Sept. 12, 1954	7.33	1,220	44.0	19	15.53	d 8,340	301	17	5.00	419	15.1
39e	French River at Webster, Mass.	85.3	Sept. 12, 1954 Mar. 19, 1936	11.64 --	2,320 4,700	27.2 55.1	19	26.05	d 14,400	169	17	--	1,300	15.3
40e	Quinebaug River at Quinebaug, Conn.	157	Sept. 21, 1938	16.21	14,100	89.8	19	g 18.96	a 19,300	314	17	6.68	2,830	18.0
41e	Quinebaug River at Putnam, Conn.	331	Sept. 21, 1938	19.45	20,900	63.1	19	g 26.5	a 48,000	145	17	g 10.34	5,150	15.6
42e	Five Mile River at Killingley, Conn.	58.2	July 24, 1938	8.52	2,480	42.6	20	5.76	1,120	19.2	17	5.27	1,020	17.5
43	Quinebaug River at Dyer Dam site near Danielson, Conn.	465	Mar. 19, 1936	--	22,800	49.0	19	--	a 43,900	94.4	--	--	--	--
44e	Moosup River at Moosup, Conn.	83.5	Mar. 12, 1936	8.35	4,260	51.0	20	5.17	1,520	18.2	16	7.00	2,930	35.1
45e	Quinebaug River at Jewett City, Conn.	711	Mar. 19, 1936	24.0	29,200	41.1	20	g 29.0	d 40,700	57.2	17	15.45	12,700	17.8
46e	Yantic River at Yantic, Conn.	88.6	Sept. 21, 1938	g 14.66	13,500	152	19	7.53	1,950	22.0	16	11.58	6,760	76.3
	CONNECTICUT RIVER BASIN													
47e	Connecticut River at Montague City, Conn.	7,865	Mar. 19, 1936	49.2	236,000	30.0	14	19.75	42,800	5.44	15	24.84	65,100	8.3
48e	Mill River at Northampton, Mass.	52.8	Mar. 31, 1951	9.38	3,840	72.7	19	11.78	d 6,300	119	15	9.81	5,010	94.8
49	Manhan River at outlet of White Reservoir near Westhampton, Mass.	4.41	--	--	--	--	19	--	1,080	245	--	--	--	--
50	Manhan River at Russellville, Mass.	15.1	--	--	--	--	19	--	ai 9,350	619	--	--	--	--
51	Bachelor Brook near South Hadley, Mass.	31.1	--	--	--	--	19	--	bi 5,320	171	--	--	--	--
52	Stony Brook at South Hadley, Mass.	19.2	--	--	--	--	19	--	d 1,920	100	--	--	--	--
53e	Ware River near Barre, Mass.	55.0	Mar. 23, 1948	5.93	1,450	26.4	20	5.53	1,120	20.4	16	6.31	1,890	34.4
54	Ware River at Twomile Bridge near Ware, Mass.	191	--	--	--	--	19	--	be 9,530	49.9				
55e	Ware River at Gibbs Crossing, Mass.	199	Sept. 21, 1938	18.2	22,700	114	19	12.83	a 12,200	61.3	17	5.37	2,360	11.9
56e	Swift River at West Ware, Mass.	188	Mar. 19, 1936	15.0	7,590	40.4	19	5.68	j 955	--	--	--	--	--
57	Fivemile River at outlet of Brooks Pond near North Brookfield, Mass.	13.2	--	--	--	--	19	---	d 1,730	131	--	--	--	--
58	Lamberton Brook near West Brookfield, Mass.	4.47	--	--	--	--	19	--	a 4,140	926	--	--	--	--
59	Quaboag River at Warren, Mass.	134	--	--	--	--	19	--	bi 4,730	35.3	--	--	--	--
60	O'Neil Brook at West Warren, Mass.	2.04	--	--	--	--	19	--	a 1,670	819	--	--	--	--

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(Compiled by U.S. Geological Survey)

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			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	CONNECTICUT RIVER BASIN Continued													
61*	Quaboag River at West Brimfield, Mass.	151	Sept. 21, 1938	11.8	8,470	56.1	19	14.79	a 12,800	84.8	19	4.97	1,260	8.3
62	Blodgett Mill Brook near West Brimfield, Mass.	7.38	--	--	--	--	19	--	a 5,860	794	--	--	--	--
63	Foskett Mill Stream near Fentonville, Mass.	6.65	--	--	--	--	19	--	di 3,900	506	--	--	--	--
64	Chicopee Brook at South Monson, Mass.	4.69	--	--	--	--	19	--	1,700	363	--	--	--	--
65	Conant Brook near South Monson, Mass.	7.94	Sept. 1938	--	1,230	155	19	--	d 5,600	705	--	--	--	--
66	Broad Brook near Belchertown, Mass.	7.07	--	--	--	--	19	--	a 4,740	670	--	--	--	--
67	Twelvemile Brook near North Wilbraham, Mass.	9.56	--	--	--	--	19	--	ai 8,690	--	--	--	--	--
68*	Chicopee River at Indian Orchard, Mass.	688	Sept. 21, 1938	--	45,200	65.7	19	22.	ai 40,500	80.7	18	9.27	5,800	8.4
69	Mill River at Springfield, Mass.	33.9	--	--	--	--	19	12.02	1,960	57.8	--	--	--	--
70*	Westfield River at Knightville, Mass.	162	Sept. 21, 1938	gk 29.58	37,900	234	28	6.67	h 4,680	--	--	--	--	--
71*	Middle Branch Westfield River at Goss Heights, Mass.	52.6	Mar. 12, 1936 Sept. 21, 1938	13.87 10.61	-- 19,900	-- 378	19	11.33	a 16,500	314	15	6.90	6,440	122
72	Walker Brook at Chester, Mass.	17.7	--	--	--	--	19	--	a 5,220	295	--	--	--	--
73*	West Branch Westfield River at Huntington, Mass.	93.7	Sept. 21, 1938	15.5	21,800	233	19	15.27	a 26,100	278	15	10.47	12,400	--
74	Stage Brook near Russell, Mass.	5.21	--	--	--	--	19	--	a 4,910	942	--	--	--	--
75	Black Brook near Russell, Mass.	2.97	--	--	--	--	19	--	d 1,760	593	--	--	--	--
76	Potash Brook at Blanford-Russell town line, Mass.	1.53	--	--	--	--	19		a 1,210	791	--	--	--	--
77	Westfield River at Woronoco, Mass.	351	--	--	--	--	19	--	dh 61,500	--	--	--	--	--
78	Cobble Mountain Reservoir tributary near Granville, Mass.	0.66	--	--	--	--	19	--	c 415	629	--	--	--	--
79	Cooks Brook at West Parish, Mass.	0.32	--	--	--	--	19	--	ce 218	681	--	--	--	--
80	Dickinson Brook near Granville, Mass.	6.42	--	--	--	--	19	--	a 5,750	896	--	--	--	--
81	Westfield Little River at Stevens Paper Co. Dam at Westfield, Mass.	77.7	--	--	--	--	19	--	dj 21,700	279	--	--	--	--
82	Powder Mill Brook near Westfield, Mass.	2.50	--	--	--	--	19	--	ce 5,740	2,300	--	--	--	--
83	Great Brook at Southwick, Mass.	19.3	--	--	--	--	19	--	cej 3,610	187	--	--	--	--
84*	Westfield River near near Westfield, Mass.	497	Sept. 21,22,1938	29.4	55,500	112	19	34.2	dh 70,300	--	16	21.78	h 31,000	--
85*	Connecticut River at Thompsonville, Conn.	9,661	Mar. 20, 1936	16.6	282,000	29.2	19	10.93	h 174,000	--	16	6.50	h 92,900	--
86	Clay Brook near Suffield, Conn.	0.69	--	--	--	--	19	--	c 531	770	--	--	--	--
87	Stony Brook near Suffield, Conn.	36.9	--	--	--	--	19	--	a 17,300	469	--	--	--	--
88	Scantic River at Scantic, Conn.	66.0	--	--	--	--	19	--	b 15,400	233	--	--	--	--
89*	Scantic River at Broad Brook, Conn.	98.4	Sept. 21, 1938	16.08	7,360	74.8	19	g 19.9	a 13,500	135	17	7.44	879	8.9
90	Fall River at Otis Reservoir Outlet near Cold Spring, Mass.	17.2	--	--	--	--	19	--	1,320	76.7	--	--	--	--

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			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	CONNECTICUT RIVER BASIN Continued													
91	Silver Brook at West New Boston, Mass.	6.52	--	--	--	--	19	--	a 4,370	67.0	--	--	--	--
92	Clam River at West New Boston, Mass.	29.3	--	--	--	--	19	--	a 12,100	413	--	--	--	--
93*	West Branch Farmington River near New Boston, Mass.	92.0	Sept. 21, 1938	12.94	i 18,500	i 201	19	14.06	a 34,300	373	16	9.35	7,910	86
94	West Branch Farmington River near Riverton, Conn.	130	--	--	--	--	19	--	a 58,000	446	16	13.40	11,000	86
95	Mad River near Winsted, Conn.	19.7	--	--	--	--	19	--	a 10,200	518	--	--	--	--
96	Colebrook Brook near Winsted, Conn.	2.84	--	--	--	--	19	--	a 1,660	585	--	--	--	--
97	Highland Lake outflow at Winsted, Conn.	7.30	--	--	--	--	19	--	ad 4,050	555	--	--	--	--
98	Sandy Brook near Robertsville, Conn.	31.1	--	--	--	--	19	--	b 10,100	325	--	--	--	--
99*	Still River at Robertsville, Conn.	84.4	Dec. 31, 1948	10.12	9,550	113	19	g 16.48	a 44,000	522	16	10.02	9,270	110
100*	West Branch Farmington River at Riverton, Conn.	216	Sept. 21, 1938	17.95	37,100	172	19	g 20.3	101,000	468	16	--	20,000	92.6
101	Morgan Brook near Winsted, Conn.	6.39	--	--	--	--	19	--	c 2,510	393	--	--	--	--
102	Hubbard River near West Hartland, Conn.	19.9	--	--	--	--	19	--	c 10,500	528	--	--	--	--
103	Valley Brook near West Hartland, Conn.	7.20	--	--	--	--	19	--	a 8,260	1,150	--	--	--	--
104	Beaver Brook near Barkhamsted, Conn.	5.31	--	--	--	--	19	--	c 3,350	631	--	--	--	--
105	Farmington River near Collinsville, Conn.	360	Sept. 21, 1938	--	54,000	150	19	--	a 140,000	389	--	--	--	--
106*	Burlington Brook near Burlington, Conn.	4.12	Sept. 21, 1938	7.24	676	164	19	9.22	d 1,720	418	16	6.24	475	115
107*	Pequabuck River at Forrestville, Conn.	45.2	Dec. 31, 1948 Sept. 1938	6.70 g 7.3	3,260 3,800	72.1 84.1	19	g 13.22	a 11,700	259	16	g 7.67	3,970	87.9
108	East Branch Salmon Brook at North Granby, Conn.	13.2	--	--	--	--	19	--	a 14,300	1,080	--	--	--	--
109	West Branch Salmon Brook at West Granby, Conn.	11.7	--	--	--	--	19	--	a 10,500	897	--	--	--	--
110*	Salmon Brook near Granby, Conn.	60.6	Dec. 31, 1948	13.55	3,440	56.8	19	g 23.58	40,000	660	16	12.13	10,800	178
111*	Farmington River at Rainbow, Conn.	584	Sept. 22, 1938 Jan. 1, 1949	-- 13.83	29,000	51.2	19	g 23.5	d 69,200	118	16	16.35	34,700	59.4
112*	South Branch Park River at Hartford, Conn.	40.6	Sept. 21, 1938	13.6	3,600	88.7	19	g 19.65	7,000	172	16	g 15.6	3,160	77.9
113	North Branch Park River near Hartford, Conn.	18.6	--	--	--	--	19	--	a 7,980	429	--	--	--	--
114*	North Branch Park River Hartford, Conn.	25.3	Jan. 25, 1938	11.6	3,000	119	19	g 18.8	10,000	395	16	12.4	3,680	146
115*	Park River at Hartford, Conn.	74.0	Jan. 25, 1938	9.16	5,650	76.4	19	g 16.36	a 16,200	219	16	g 10.6	6,690	90.4
116*	Hockanum River near East Hartford, Conn.	74.5	Sept. 21, 1938	g 13.78	5,160	69.3	19	10.46	2,740	36.8	16	7.96	1,520	20.4
117*	Salmon River near East Hampton, Conn.	105	Sept. 21, 1938	10.96	12,400	118	19	6.02	4,870	46.4	16	8.21	9,130	86.8
118*	East Branch Eight mile River near North Lyme, Conn.	22.0	Sept. 21, 1938	7.00	2,950	134	19	3.49	467	21.2	16	5.90	2,130	97.0
119*	West Branch Eightmile River at North Plain, Conn.	18.6	Sept. 21, 1938	--	1,810	97.3	19	5.80	750	40.3	15	7.72	2,350	126

TABLE II-1

SUMMARY OF FLOOD DISCHARGES IN SOUTHERN NEW ENGLAND

(Compiled by U.S. Geological Survey)

No.	STREAM AND LOCATION	DRAINAGE AREA (Sq. Mi.)	PREVIOUS MAXIMUM FLOOD				AUGUST 1955 FLOOD				OCTOBER 1955 FLOOD			
			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	CONNECTICUT RIVER BASIN Continued													
119A*	Connecticut River at Middletown, Conn.	10,870	Mar. 21, 1936	25.3	267,000	24.6	20	20.44	h 177,000	--	17	13.89	h 114,000	--
	MENUNKETESUCK RIVER BASIN													
120*	Menunketesuck River near Clinton, Conn.	11.5	Sept. 11, 1954	8.51	1,600	138	19	3.43	195	16.3	16	5.93	709	61.1
	QUINNIPIAC RIVER BASIN													
121*	Quinnipiac River at Wallingford, Conn.	109	Sept. 21, 1938	9.55	5,230	48.0	20	9.01	3,790	34.8	17	8.49	3,000	27.5
	HOUSATONIC RIVER BASIN													
122*	Housatonic River near Great Barrington, Mass.	280	Jan. 1, 1949	12.08	12,200	43.6	19	9.65	6,060	21.6	17	8.43	4,320	15.4
123*	Blackberry River at Canaan, Conn.	48.2	Nov. 26, 1950 Dec. 31, 1948	9.37 12.0	2,550 --	52.9 --	19	13.01	a 14,200	295	16	9.12	2,930	58.7
124*	Housatonic River at Falls Village, Conn.	632	Jan. 1, 1949	g 22.9	23,900	37.8	19	g 22.3	bd 22,700	35.9	--	--	--	--
125	Salmon Creek near Lime Rock, Conn.	30.1	--	--	--	--	19	--	b 6,300	209	--	--	--	--
126	Birdseye Brook near Cornwall, Conn.	3.88	--	--	--	--	19	--	a 1,300	335	--	--	--	--
127	Furnace Brook at Cornwall Bridge, Conn.	13.5	--	--	--	--	19	--	c 4,060	301	--	--	--	--
128*	Tenmile River near Gaylordsville, Conn.	204	Sept. 22, 1938	12.77	12,500	61.3	19	g 11.9	17,400	85.3	16	10.95	8,960	43.9
129*	Housatonic River at Gaylordsville, Conn.	994	Jan. 1, 1949 Sept. 22, 1938	14.85 g 14.5	32,300 37,000	32.5 37.2	19	18.58	51,300	52.1	16	12.45	21,600	21.7
130	West Aspetuck River near Merryall, Conn.	16.6	--	--	--	--	19	--	a 1,830	110	--	--	--	--
131	Still River at Danbury, Conn.	38.3	--	--	--	--	19	--	a 2,770	72.3	--	--	--	--
132*	Still River near Lanesville, Conn.	68.5	Sept. 22, 1938	10.88	4,410	64.4	19	11.20	3,900	56.9	16	g 11.1	7,980	116
133	Bantam River at Litchfield, Conn.	20.6	--	--	--	--	19	--	a 10,100	490	--	--	--	--
134*	Shepaug River near Roxbury, Conn.	133	Sept. 21, 1938	g 12.8	10,500	78.9	19	g 17.2	a 50,300	378	16	11.51	7,760	58.3
135	Sprain Brook near Hotchkissville, Conn.	6.91	--	--	--	--	19	--	a 2,980	431	--	--	--	--
136	Norwaug River near Woodbury, Conn.	25.6	--	--	--	--	19	--	ce 12,300	480	--	--	--	--
137*	Pomperaug River at Southbury, Conn.	75.3	Sept. 21, 1938	16.0	7,420	98.5	19	21.8	a 29,400	390	16	g 15.75	8,860	118
138	Transylvania Brook near Southbury, Conn.	2.45	--	--	--	--	19	--	a 830	342	--	--	--	--
139*	Housatonic River at Stevenson, Conn.	1,545	Mar. 12, 1936	g 23.5	69,500	45.0	19	23.42	69,300	44.9	16	21.50	75,800	49.0
140	West Branch Naugatuck River near West Torrington, Conn.	24.2	--	--	--	--	19	--	a 11,900	492	--	--	--	--
141	East Branch Naugatuck River near Torrington, Conn.	10.2	--	--	--	--	19	--	a 6,210	609	--	--	--	--
142*	Naugatuck River near Thomaston, Conn.	71.9	Dec. 31, 1948	12.05	10,200	142	19	g 24.0	a 41,600	579	15	10.50	8,100	112
143*	Leadmine Brook near Thomaston, Conn.	24.0	Sept. 17, 1934	c 11.2	3,080	128	19	g 13.1	b 10,400	433	16	9.60	3,080	128
144	Branch Brook near Thomaston, Conn.	21.0	--	--	--	--	19	--	c 10,300	490	--	--	--	--

TABLE II-1

SUMMARY OF FLOOD DISCHARGES IN SOUTHERN NEW ENGLAND

(Compiled by U.S. Geological Survey)

No.	STREAM AND LOCATION	DRAINAGE AREA (Sq. Mi.)	PREVIOUS MAXIMUM FLOOD					AUGUST 1955 FLOOD				OCTOBER 1955 FLOOD			
			Date	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.	Day	Gage Height (feet)	Discharge (c.f.s.)	C.F.S. per Sq. Mi.
	HOUSATONIC RIVER BASIN Continued													
145	Naugatuck River near near Waterbury, Conn.	138	--	--	--	--	19	--	75,000	550	--	--	--	--
146	Hancock Brook near Waterbury, Conn.	12.9	--	--	--	--	19	--	a 4,870	378	--	--	--	--
147	Steel Brook at Oakville, Conn.	12.9	--	--	--	--	19	--	c 5,890	457	--	--	--	--
148	Mad River at Waterbury, Conn.	18.0	--	--	--	--	19	--	d 2,070	115	--	--	--	--
149	Hop Brook near Naugatuck, Conn.	16.5	--	--	--	--	19	--	e 2,750	161	--	--	--	--
150*	Naugatuck River near Naugatuck, Conn.	245	Dec. 31, 1948	12.40	28,500	116	19	g 25.7	a 106,000	431	16	g 13.7	30,100	124
151*	Shepaug River at Woodville, Conn.	38.0	Sept. 21, 1938	--	4,000	158	19		13,800	363	16	--	3,900	103
	SAUGATUCK RIVER BASIN													
152*	Saugatuck River near Westport, Conn.	77.5	Mar. 12, 1936	11.30	5,610	60.5	19	8.04	2,530	32.6	16	g 15.93	14,800	191

NOTES:

* U.S. Geological gaging station.

(a) Slope-area measurement.

(b) Contracted opening measurements.

(c) Computation of flow through culvert.

(d) Computation of flow over dam.

(e) Computation of flow over embankment.

(f) Based on net drainage area.

(g) From flood marks.

(h) Affected By flood control reservoir upstream.

(i) Affected by failure of dams or dams upstream.

(j) Affected by storage in upstream reservoirs.

(k) Site and datum previously used.

TABLE II-2

TRIBUTARY CONTRIBUTIONS TO AUGUST 1955 FLOOD PEAKS

BLACKSTONE RIVER BASIN

Contributing Area	Drainage Area (Sq. Mi.)	DISCHARGE IN CUBIC FEET PER SECOND			
		Tributary Peak Discharge	Worcester U.S.G.S. Gage 31 Sq. Mi.	Northbridge U.S.G.S. Gage 139 Sq. Mi.	Woonsocket U.S.G.S. Gage 416 Sq. Mi.
Kettle Brook at Worcester Gage	31	3,970	3,970	3,170	1,890
Tatnuck and Mill Brooks at Mouths	30	4,000	--	3,220	1,920
Local Area-Worcester to Quinsigamond River	43	7,500	--	7,500	4,460
Quinsigamond River at Mouth	35	1,200	--	1,110	660
Local Area-Northbridge to Mumford River	9	900	--	--	900
Mumford River at Mouth	58	7,000	--	--	5,700
West River at Mouth	35	6,000	--	--	4,360
Local Area-West River to Branch River	18	1,300	--	--	1,300
Branch River at Mouth	96	4,300	--	--	3,330
Local Area-Branch River to Woonsocket	14	1,500	--	--	1,480
Mill and Peters Rivers at Mouth	47	4,900	--	--	3,600
			3,970	15,000	29,600

Table II-2

TABLE II-3

TRIBUTARY CONTRIBUTIONS TO AUGUST 1955 FLOOD PEAKS

THAMES RIVER BASIN

Contributing Area	Drainage Area (Sq. Mi.)	DISCHARGE IN CUBIC FEET PER SECOND			
		Tributary Peak Discharge	Putnam U.S.G.S. Gage 331 Sq. Mi.	Jewett City U.S.G.S. Gage 711 Sq. Mi.	Willimantic U.S.G.S. Gage 401 Sq. Mi.	Norwich 1252 Sq. Mi.
Quinebaug River at Westville	94	17,500	10,000	7,100	—	6,800
Local Area-Westville to Quinebaug	63	--	16,000	11,200	—	10,800
Local Area-Quinebaug to French River	16	3,000	2,500	1,700	—	1,600
French River at Mouth	112	13,600	13,000	9,500	—	9,100
Local Area-French River to Putnam	46	7,000	6,500	4,500	—	4,300
Local Area-Putnam to Mouth of Quinebaug River	413	9,000	--	6,700	--	6,400
Willimantic River above South Coventry	121	24,200	--	--	15,400	11,000
Hop River at Mouth	81	6,000	—	—	4,400	3,500
Local Area-Hop River to Willimantic	29	2,200	—	--	1,000	800
Natchaug River at Mouth	170	1,000*	—	--	500*	200*
Local Area-Willimantic to Taftville	107	4,000	—	—	—	1,500
			48,000	40,700	21,300*	56,000*

* Modified by Mansfield Hollow Reservoir

TABLE II-4

TRIBUTARY CONTRIBUTIONS TO AUGUST 1955 FLOOD PEAKS

CONNECTICUT RIVER BASIN

Contributing Area	Drainage Area (Sq. Mi.)	DISCHARGE IN CUBIC FEET PER SECOND				
		Tributary Peak Discharge	Montague City U.S.G.S. Gage 7,863 Sq. Mi.	Holyoke Dam 8,234 Sq. Mi.	Thompsonville U.S.G.S. Gage 9,661 Sq. Mi.	Middletown U.S.G.S. Gage 10,870 Sq. Mi.
Connecticut River above mouth of Deerfield River	7,201	25,300	25,300	19,900	19,500	18,300
Deerfield River at Mouth	664	11,000	15,800	10,300	10,000	8,300
Local Area-Montague City to Holyoke	419	49,500	--	48,300	38,200	23,800
Local Area-Holyoke to Thompsonville	192	34,500	--	--	33,000	14,500
Chicopee River at Indian Orchard gage	638	40,500	--	--	36,000	21,400
Westfield River at Westfield gage	407	70,300	--	--	38,200	22,000
Local Area-Thompsonville to Middletown	625	35,000	--	--	--	24,700
Farmington River at Rainbow gage	584	69,200	--	--	--	44,000
			41,100	79,000	174,900	177,000

TABLE II-5

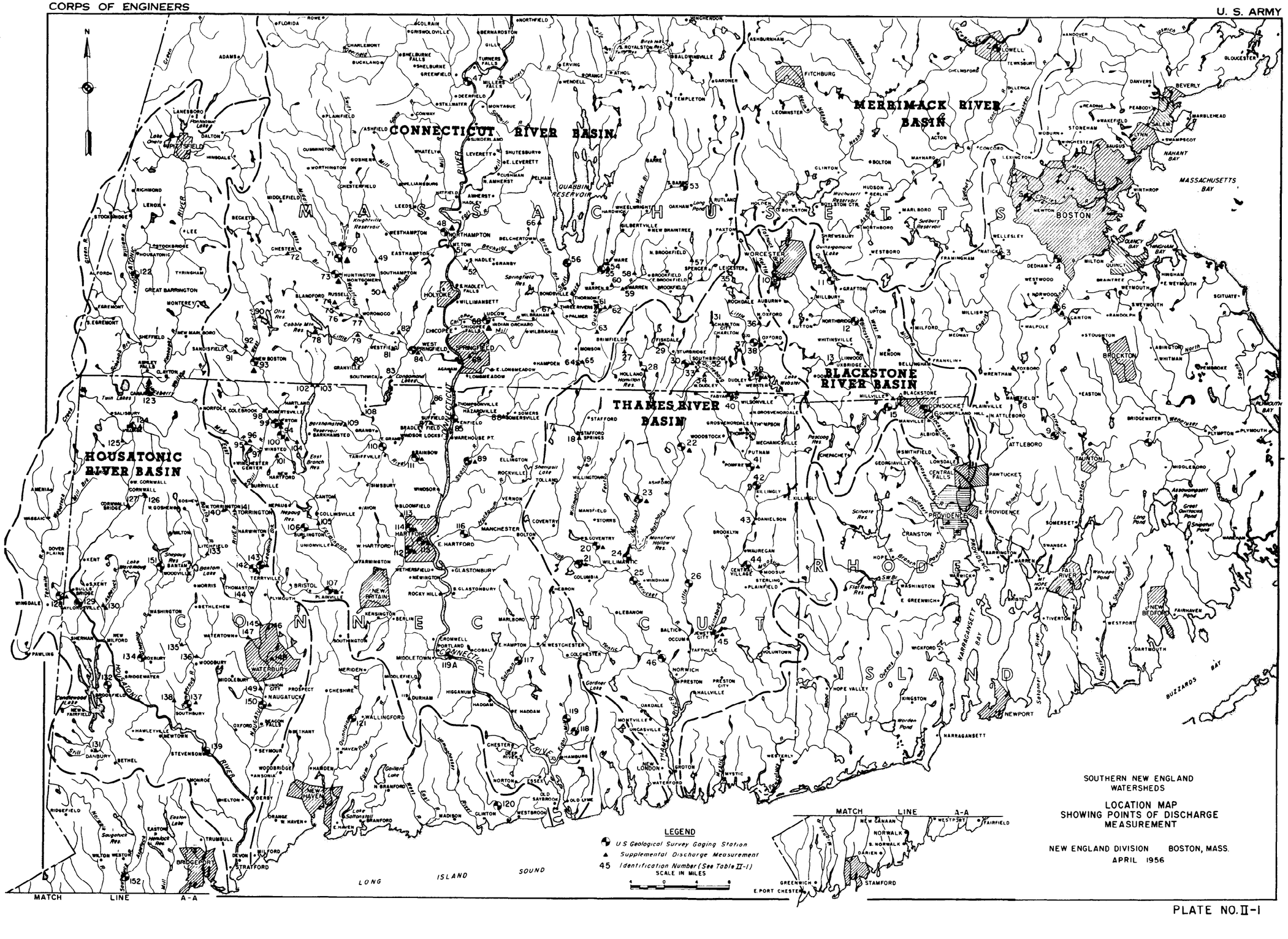
TRIBUTARY CONTRIBUTIONS TO AUGUST 1955 FLOOD PEAKS

NAUGATUCK RIVER BASIN

Contributing Area	Drainage Area (Sq.Mi.)	DISCHARGE IN CUBIC FEET PER SECOND			
		Tributary Peak Discharge	Thomaston U.S.G.S. Gage 72 Sq. Mi.	Naugatuck U.S.G.S. Gage 246 Sq. Mi.	Derby 312 Sq. Mi.
East Br. Naugatuck River at Mouth	10	6,200	6,200	4,530	4,300
West Br. Naugatuck River at Mouth	24	12,100	12,100	10,300	9,900
Local Area above Thomaston Gage	38	23,300	23,300	19,130	18,600
Leadmine Brook at Thomaston Gage	24	10,400	-	10,010	9,500
Local Area-Thomaston to Naugatuck	150	66,000	-	62,030	58,700
Local Area-Naugatuck to Ansonia	66	20,000	-	-	11,000
			41,600	106,000	112,000

CORPS OF ENGINEERS

U. S. ARMY



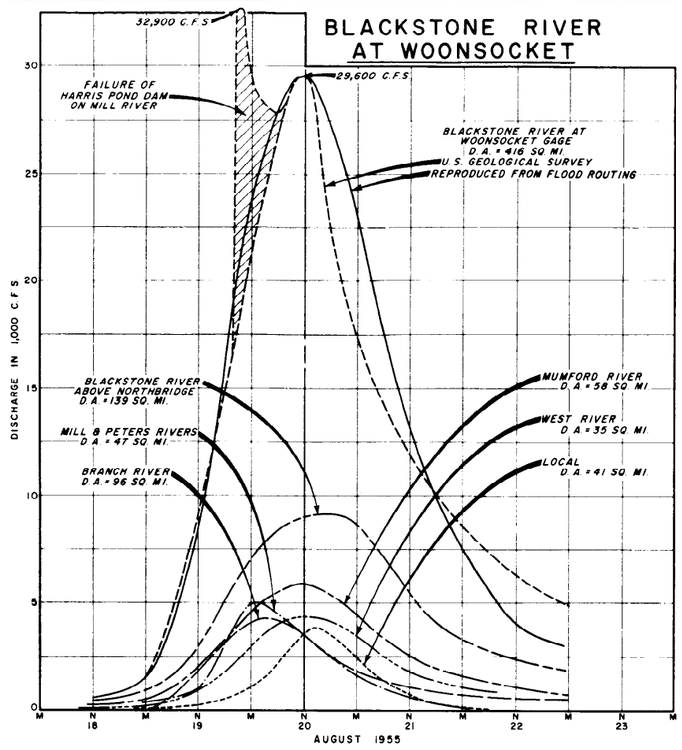
SOUTHERN NEW ENGLAND WATERSHEDS

LOCATION MAP
SHOWING POINTS OF DISCHARGE MEASUREMENT

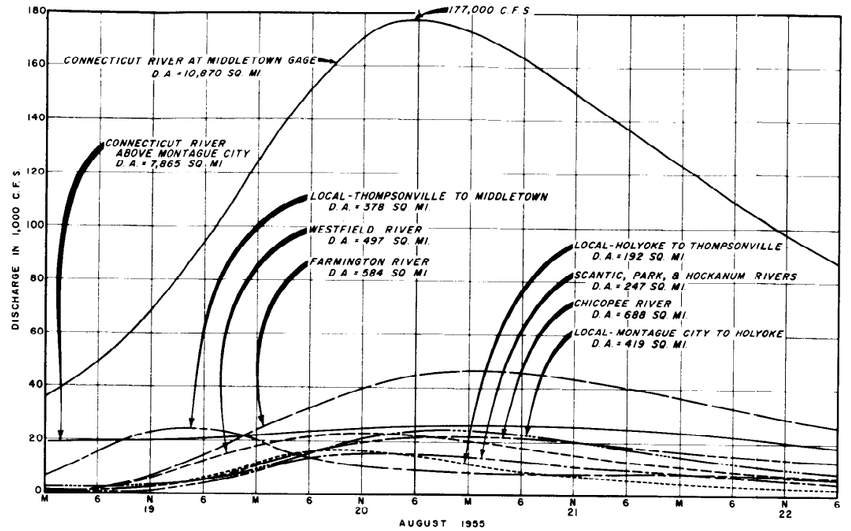
NEW ENGLAND DIVISION BOSTON, MASS.
APRIL 1956

PLATE NO. II-1

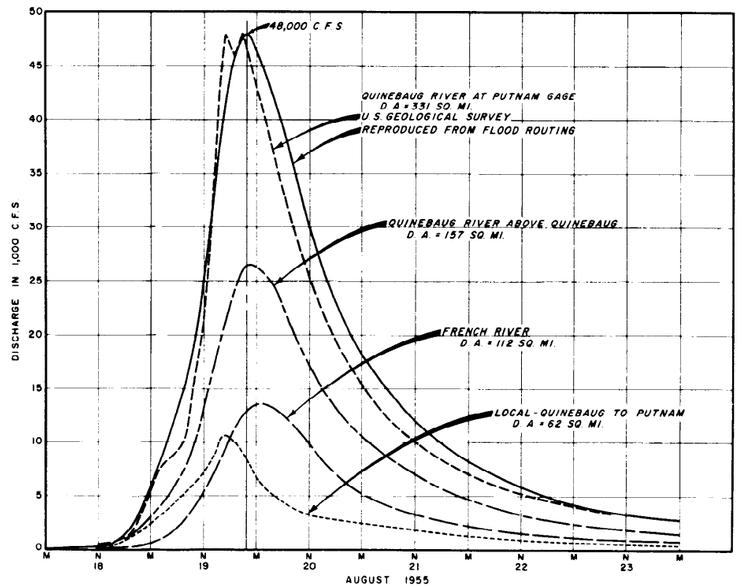
BLACKSTONE RIVER AT WOONSOCKET



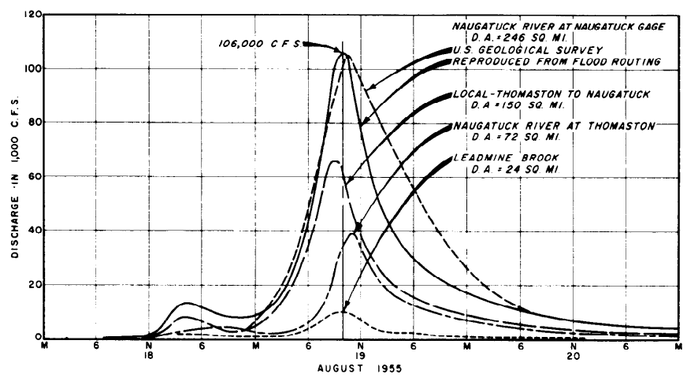
CONNECTICUT RIVER AT MIDDLETOWN



QUINEBAUG RIVER AT PUTNAM



NAUGATUCK RIVER AT NAUGATUCK



HYDROGRAPH COMPONENTS

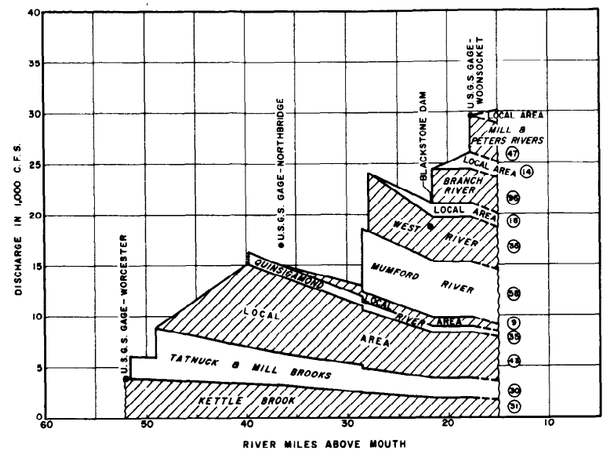
FLOOD OF AUGUST 1955

NEW ENGLAND DIVISION BOSTON, MASS.

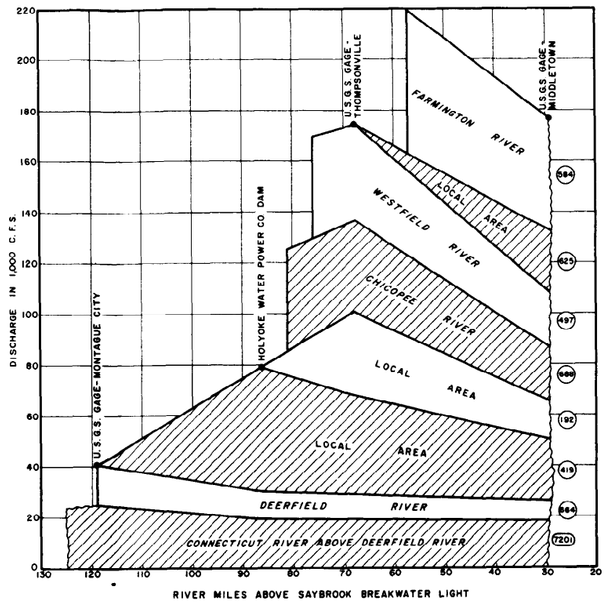
APRIL 1956

PLATE NO. II-2

BLACKSTONE RIVER



CONNECTICUT RIVER



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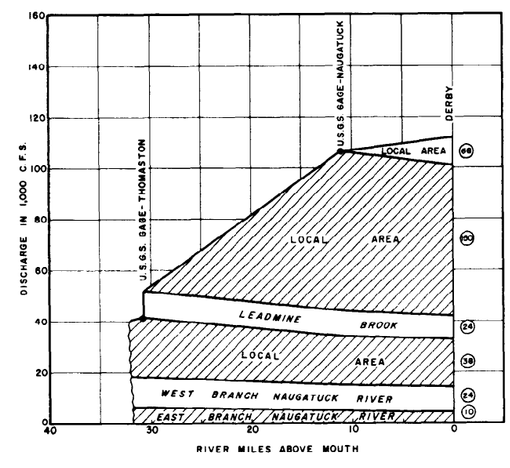
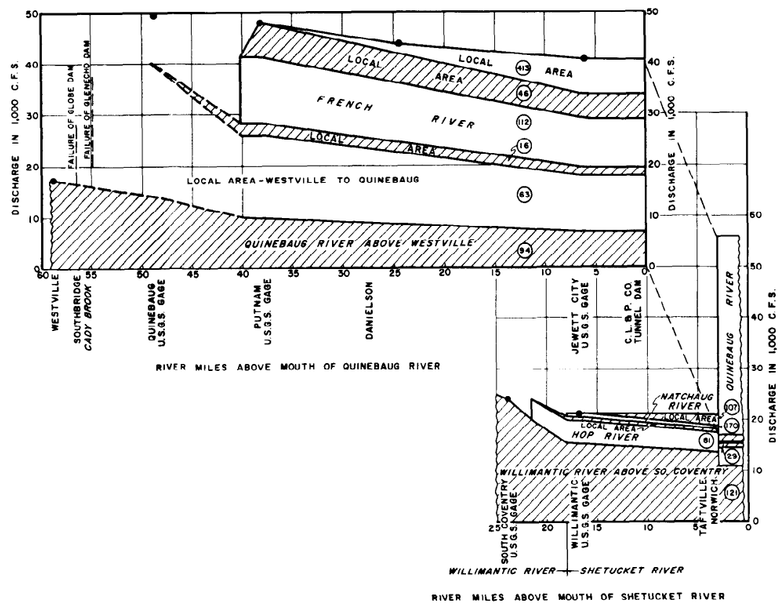


THAMES RIVER BASIN



LEGEND

(41) *Drainage Area in Square Miles*

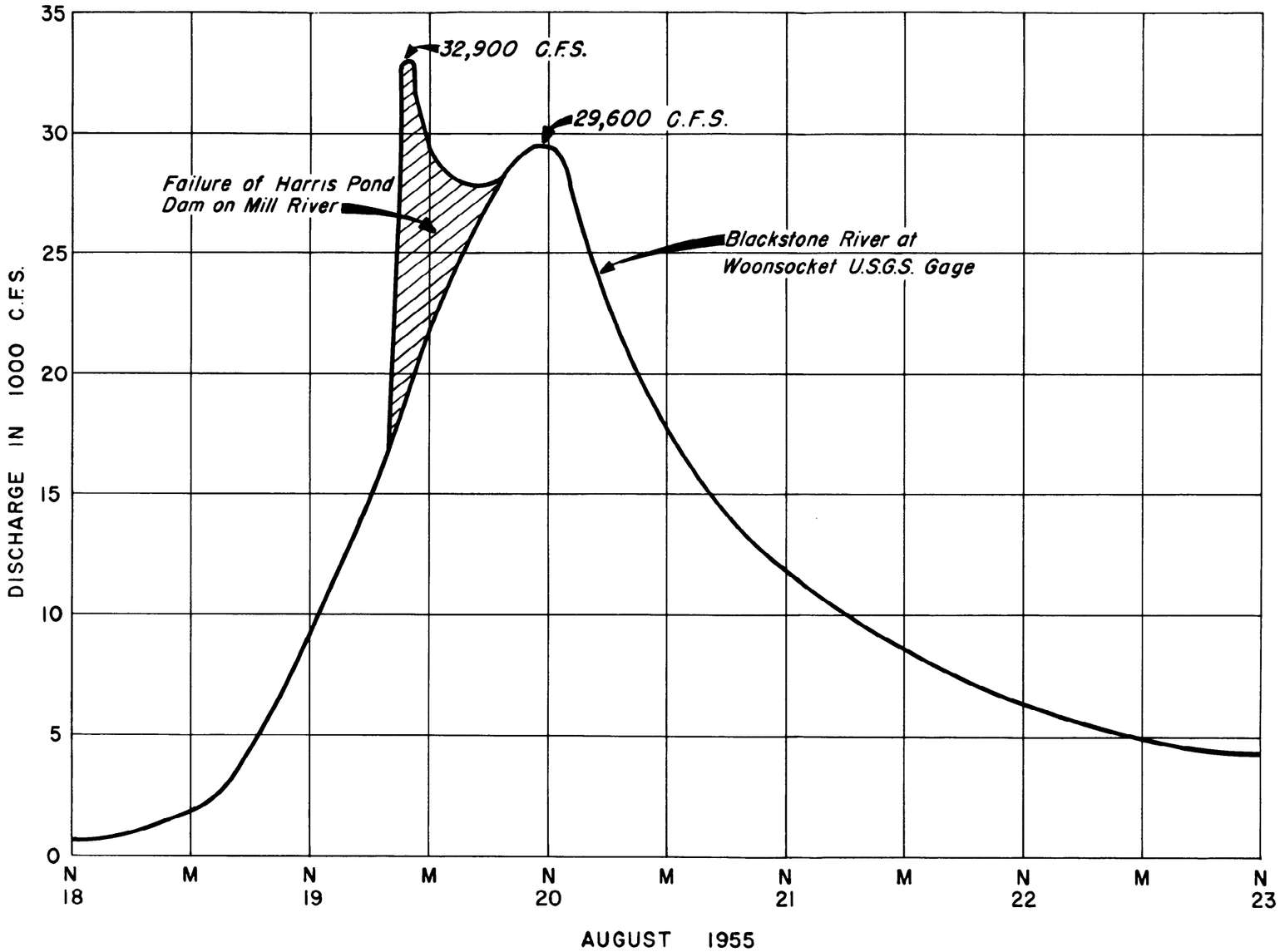
• *Observed Discharge*

PEAK DISCHARGE PROFILES AND TRIBUTARY CONTRIBUTIONS

FLOOD OF AUGUST 1955

NEW ENGLAND DIVISION BOSTON, MASS.

APRIL 1956

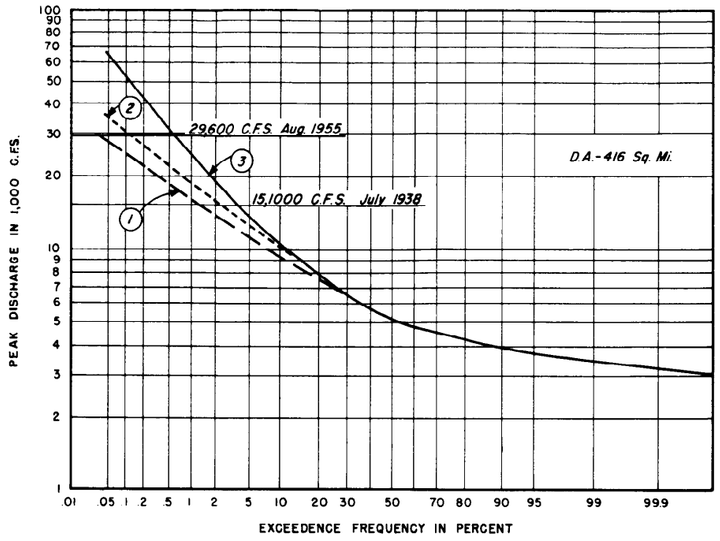


EFFECT OF DAM FAILURE ON WOONSOCKET FLOOD HYDROGRAPH

NEW ENGLAND DIVISION BOSTON, MASS.
APRIL 1956

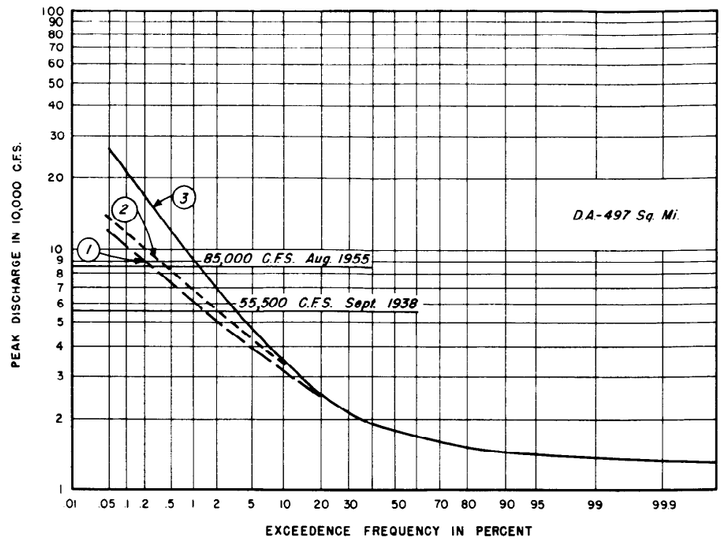
PLATE NO. II-4

BLACKSTONE RIVER BASIN



BLACKSTONE RIVER AT WOONSOCKET GAGE

CONNECTICUT RIVER BASIN



WESTFIELD RIVER AT WESTFIELD GAGE

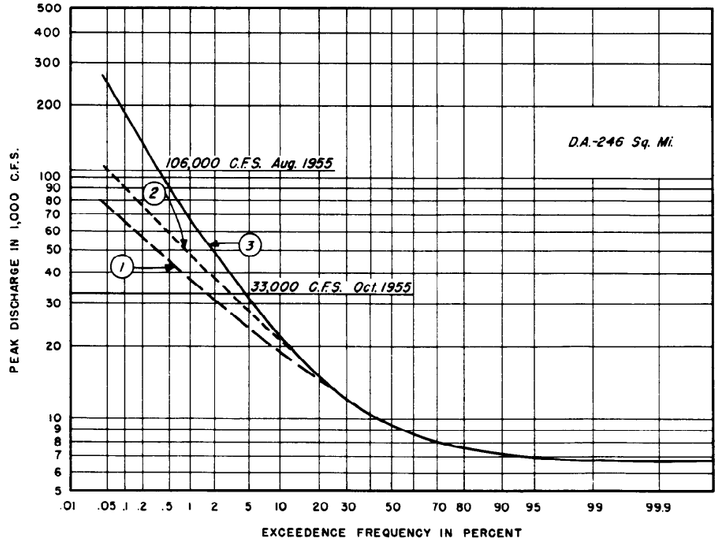
LEGEND

(1) Based on flow records through 1950 with skew = 0.30

(2) Based on flow records through 1955 with skew = 0.30

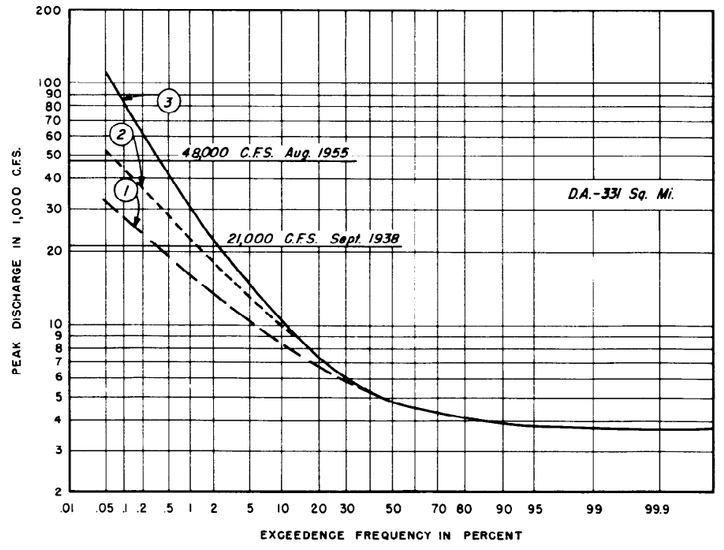
(3) Based on flow records through 1955 with skew = 1.00

HOUSATONIC RIVER BASIN



NAUGATUCK RIVER AT NAUGATUCK GAGE

THAMES RIVER BASIN



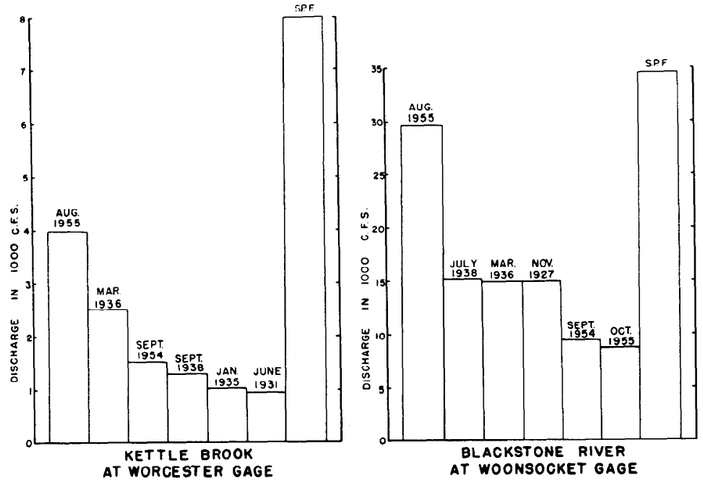
QUINEBAUG RIVER AT PUTNAM GAGE

EFFECT OF RECENT FLOODS ON DISCHARGE FREQUENCY CURVES

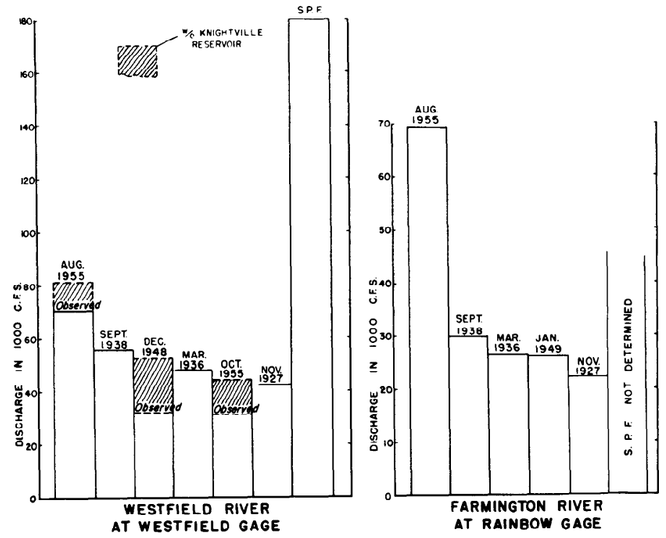
NEW ENGLAND DIVISION BOSTON, MASS.

APRIL 1956

BLACKSTONE RIVER BASIN



CONNECTICUT RIVER BASIN



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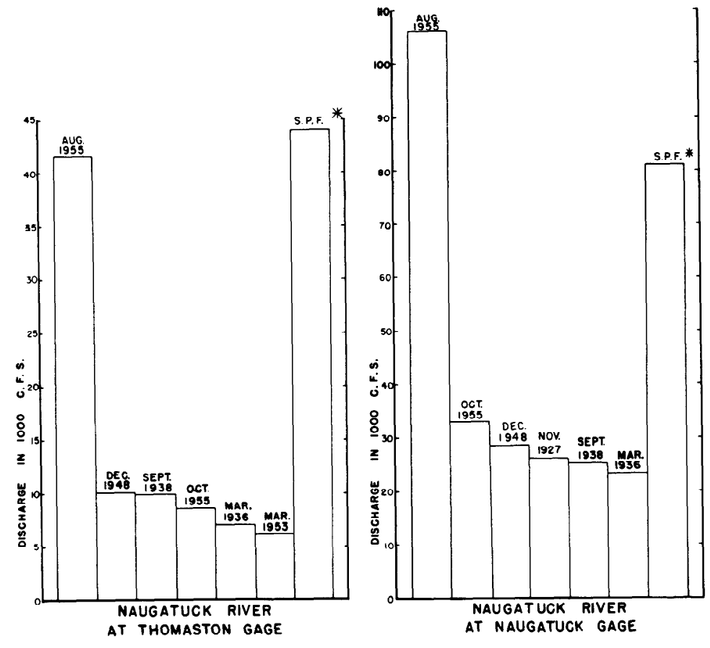
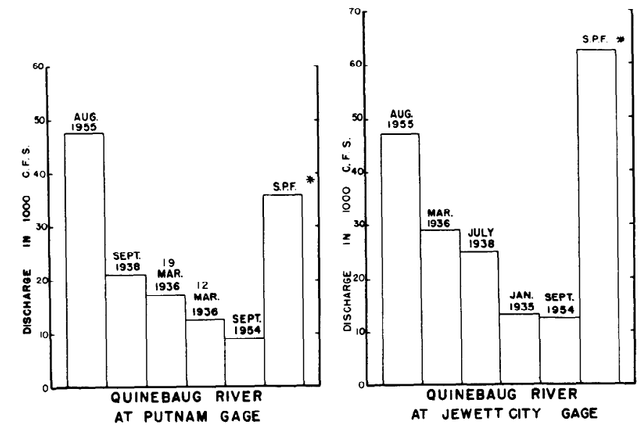


THAMES RIVER BASIN



* COMPUTED PRIOR TO AUGUST 1955 FLOOD. SUBJECT TO REVISION ON BASIS OF RECENT FLOODS.

COMPARISON OF FLOOD PEAKS AT SELECTED LOCATIONS

NEW ENGLAND DIVISION BOSTON, MASS.

APRIL 1956

PLATE NO. II-6